APPLICATION

FOR

UNITED STATES LETTERS PATENT

TITLE: OBJECT-BASED CODING AND DECODING APPARATUSES
AND METHODS FOR IMAGE SIGNALS

APPLICANT: SUNG MOON CHUN, JIN HAK LEE, JOO HEE MOON, GWANG
HOON PARK, JAE KYOON KIM, JAE-WON CHUNG

OBJECT-BASED CODING AND DECODING APPARATUSES AND METHODS FOR

IMAGE SIGNALS

Su + Cl This application is a continuation-in-part of 08/578,142 filed on 12-26-95 now abandoned.

CL BACKGROUND OF THE INVENTION

5

P+b 1. Field of the Invention

P The present invention relates to image signal compression coding and decoding, and more particularly to an apparatus for and a method of coding image signals, wherein upon scanning transform

10 coefficients of an input image signal in a shape-adaptive transform coding, only segments containing such shape-adaptive transform coefficients are scanned, thereby reducing the quantity of data being transmitted. The present invention also relates to an apparatus for and a method of decoding image signals,

15 wherein an inverse scanning for transform coefficients of a bitstream encoded in the above-mentioned manner is carried out upon decoding the bitstream, taking into consideration only segments containing those transform coefficients.

P+b 20 2. Description of the Prior Art

-P Compression coding and decoding of image signals makes it

-1-

2

possible to achieve transmission of image information while

reducing the memory capacity required to store image signals.

Thus, such compression coding and decoding techniques are very

important techniques in multimedia industries involving

5   applications such as storage and transmission of image signals.

Meanwhile, a standardization for information compression

schemes has been necessary for extension of multimedia

industries and information compatibility. To this end, various

image standardization schemes associated with a variety of

10   applications have been proposed. For example, as representative

image coding and decoding standardization schemes, there are

H.261 of International Telecommunication Union –

Telecommunication Standardization Sector (ITU-T, the successor

of CCITT) for video phone or video conference services using

15   integrated services digital networks (ISDN), and H.263 of ITU-

T for transmission of video information using public switched

telephone networks (PSTN), MPEG-1 proposed by Moving Picture

Experts Group (MPEG) of International Standardization

Organization/International Electrotechnical Commission Joint

20   Technical Committee 1/Sub Committee 29/Working Group 11 (ISO/IEC

JTC1/SC29/WG11) for storage media, and MPEG-2 for high quality

digital broadcasting associated with high definition

-2-

3

televisions (HDTV) and enhanced digital television(EDTV). Standardization for compressive coding of still image signals also has been made by, for example, Joint Photographic Coding Experts Group (JPEG) of ISO/IEC JTC1/SC29/WG1.

5   In most conventional image signal coding schemes, the entire segment of a rectangular frame or picture is encoded. Such schemes are called "frame-based coding". In such image signal coding schemes, texture information of all pixels included in a frame, namely, luminance and chrominance, is
10   encoded and transmitted.

       Recently, the demands for multimedia products have been increased which have functions of coding or manipulating only particular regions - or object - of a frame interested or needed to the user without coding the entire region of the frame. To
15   this end, active research has recently been conducted for object-based coding schemes adapted to encode only arbitrary shape region of a frame, as a substitute for frame-based coding schemes adapted to encode the entire region of a frame. Figs. 1 and 2 illustrate test images for explanation of such an
20   object-based coding scheme, respectively. Fig. 1 is a frame showing features of two children playing with a ball in an arbitrary space (background). Where information, only

-3-

associated with the children and ball, of the image is to be encoded and transmitted coding of such information can be achieved using the object-based coding scheme, that is, only texture information values of pixels associated with the

5   children and ball are encoded and transmitted. In this case, the regions respectively associated with the children and ball are designated to be an object, whereas the remaining region of the picture other than the object is considered to be a background.

For coding of the picture shown in Fig. 1 using the

10   object-based coding scheme, all pixels included in the frame should be distinguished into those associated with the children and ball and those associated with the background in an encoder and a decoder. This information is referred as shape information of the object. In order to allow the decoder to recognize the

15   shape information, the encoder should efficiently encode the shape information and then transmit the shape information to the decoder. For thus, the object-based encoder and decoder have a most remarkable difference from the frame-based encoder and decoder in that they include a shape information encoder and a

20   shape information decoder, respectively.

Fig. 2 shows shape information included in the image information where only the children and ball are considered to be

-4-

5

an object.   In this case, the pixels associated with the children
and ball have shape information bearing a bright value whereas the
pixels associated with the background have shape information
bearing a dark value.   Such shape information of pixels assigned

5   with different values to distinguish those of the pixels
associated with the object from those associated with the
background is called a "binary mask".   Shape information may also
be expressed by a contour indicative of the boundary between the
background and the object.   A transformation can be made between

10   the shape information in the form of a binary mask and the shape
information in the form of a contour.   That is, the shape
information having the form of a binary mask can be expressed into
contour information by carrying out a contour extraction.   On the
other hand, a contour filling is carried out for obtaining a

15   binary mask from contour information.

Representative examples of frame-based coding schemes
include H.261 and H.263 of ITU-T, MPEG-1 and MPEG-2 of ISO/IEC
JTC1/SC29/WG11,   and   JPEG   of   ISO/IEC   JTC1/SC2   all   being
standardized   schemes.   On   the   other   hand,   representative

20   examples   of   object-based   coding   schemes   include   MPEG-4   of
ISO/IEC JTC1/SC29/WG11 and JPEG2000 of ISO/IEC JTC1/SC29/WG11.

Transform coding is the most widely used coding method in

-5-

6

well-known compressive coding schemes for image signals. In such a transform coding, an image signal is transformed to transform coefficients - or frequency coefficients and low frequency components are mainly transmitted while suppressing

5 transmission of high frequency components. This scheme has an advantage of a high compression ratio while minimizing the degradation of picture quality. Examples of such a transform coding scheme include a discrete Fourier transform (DFT), a discrete cosine transform (DCT), a discrete sine transform (DST),

10 and a Walsh-Hadamard transform (WHT).

Of such transform schemes, DCT is a scheme providing a superior compactness of image signal energy on low-frequency components. In other words, DCT provides a superior picture quality over other transform schemes, in spite of only using a

15 reduced number of low frequency transform coefficients. In addition, there is a fast algorithm for DCT. By virtue of such an advantage, DCT has been used in various image coding standardization schemes such as H.261, H.263, MPEG-1, MPEG-2, MPEG-4, and JPEG.

20 Research of such transform coding schemes has been made with respect to image signals in blocks each consisting of a set of

-6-

7

pixels(picture elements or pels) with a certain size. In
accordance with transform coding schemes developed, a
rectangular frame is divided into a plurality of blocks having the
same size. A transform coding is then carried out for each block.

5   In the case of an object-based coding scheme only texture
information included in objects is encoded, as compared to
frame-based coding scheme in which texture information of all
pixels included in a rectangular frame is completely encoded. In
such an object-based coding scheme, accordingly, it is required

10   to conduct a transform coding only for image signal of some pixels
of blocks associated to the object. Fig. 3 illustrates an object
having an arbitrary shape in a frame divided into a plurality of
blocks. In Fig. 3, each square region is indicative of one block.
Dark region is indicative of a set of pixels associated with the

15   object. In Fig. 4, transparent blocks correspond to blocks of
Fig. 3 not to be encoded because of including no object pixel,
respectively. The black blocks of Fig. 4 are indicative of
blocks which are to be transformed by one of the known transform
coding schemes because all pixels thereof are object pixels. The

20   gray blocks of Fig. 4 are indicative of blocks each including both
the object pixels and the non-object pixels, thereby requiring a
transform coding only for texture information of a part of pixels

-7-

8

thereof. In the following description, blocks corresponding to such gray blocks are referred to as "boundary blocks". This scheme, in which a transform coding is not conducted for the entire pixels of each square block, but conducted for a part of

5   pixels included in each square block, is called a "shape-adaptive transform coding".

In a representative shape-adaptive transform coding scheme, each block which is a coding unit consists of 8x8 pixels. Namely, blocks include 8 lines per block and 8 pixels per line. In

10   accordance with the scheme, texture signal of object pixels to be encoded are processed by an one-dimensional DCT in a vertical direction and then in a horizontal direction.

Referring to Fig. 5A, an 8x8 block is illustrated which has an object region to be encoded. In Fig. 5A, gray pixels are pixels

15   associated with objects. For processing an shape-adaptive DCT coding for texture signal of object pixels to be encoded, a re-arrangement of pixels is carried out by vertically shifting those object pixels to the upper border of the block, thereby filling that border, as shown in Fig. 5B. In this state, one-

20   dimensional DCT is performed in a vertical direction (indicated by thick lines in Fig. 5) for texture information of each column including object pixels. As a result, transform coefficients of

-8-

9

one-dimensional DCT are generated, as shown in Fig. 5C. The

solid circles in Fig. 5C denote positions of mean values of

vertical one-dimensional DCT, namely, direct current (DC) values,

respectively. After completing the vertical one-dimensional

5 DCT as shown in Fig. 5D, a pixel re-arrangement is conducted again

by shifting again the object pixels to the left border of the block.

Thereafter, one-dimensional DCT is performed in a horizontal

direction for the transform coefficients included in each of rows,

which comprise at least one transform coefficient, as shown in Fig.

10 5E. Fig. 5F shows positions of transform coefficients

completing the one-dimensional DCT in both the vertical and

horizontal directions. This procedure, namely, the transform,

in which one directional DCT is carried out in a successive manner

in the vertical and horizontal directions, is called a "shape-

15 adaptive DCT". It should be noted that the positions of

transform coefficients resulting from the shape-adaptive DCT may

not be coincide with those of input object pixels (or input shape

information) and that the positions of those transform

coefficients are determined only based on the input shape

20 information. The number of transform coefficients resulting

from the shape-adaptive DCT is equal to the number of object

pixels, as in the conventional block-wised DCT schemes.

-9-

CO

Fig. 6 illustrates a block diagram of a conventional shape-adaptive image signal coding apparatus(=texture information encoding part 24) which utilizes the above mentioned shape-adaptive DCT. This apparatus 24 receives, as an

5   input thereof, shape information on a block basis having a MxN size (M and N are integer values larger than zero) and texture information of object pixels in the form of a block having the same size as the shape information block. In the case of Figs. 5A to 5F, block of M=8 and N=8 is inputted. The apparatus 24 generates

10   an output in the form of a bitstream. The outputted bitstream is transmitted to a receiver. Otherwise, the bitstream may be transmitted to a multiplexer (MUX) so that it is multiplexed with other signals, for example, bitstreams of shape information.

An shape-adaptive DCT part 10 first performs a shape-

15   adaptive DCT for input texture information of object pixels, based on input shape information, thereby outputting transform coefficients which are positioned at the upper left portion of an associated block, as shown in Fig. 5F. For these transform coefficients, a quantization is conducted for data compression

20   in a quantization part 11. As a result, quantized transform coefficients are outputted from the quantization part 11. The

-10-

11

transform coefficients from the quantization part 11 are then

transmitted to a scanning part 12 which, in turn, carries out a

scanning procedure for arranging the received transform

coefficients into a one-dimensional array. Various scanning

5   methods applicable to blocks of M=8 and N=8 are illustrated in

Figs. 7A to 7C.   Fig. 7A illustrates a zig-zag scanning order most

widely used.   In Fig. 7A, the numerals indicated on respective

portions of the block are indicative of the scanning order of

corresponding transform coefficients upon arranging those

10   transform coefficients in a one-dimensional array.   The scanning

methods of Figs. 7A to 7C can be selectively used in accordance

with the characteristics of input image signals to be subjected

to a transform coding.   These scanning methods are also used in

MPEG-2 and MPEG-4 schemes.   Blocks, which are processed by the

15   shape-adaptive DCT, may include segments containing no transform

coefficient, as shown in Fig. 5F.   In accordance with a

conventional schemes, a scanning operation is carried out for the

entire segment of a block in a sequential manner according to a

well-known, predetermined scanning order while setting

20   transform coefficient values of segments containing no transform

coefficient to "zero". That is, all segments - 64 transform

coefficients in the case of an 8x8 block - are sequentially

-11-

/2-

scanned using one of the known scanning methods, irrespective of whether or not the segments to be scanned contain transform coefficients. The resultant transform coefficients arranged in a one-dimensional array are subjected to a variable-length

5 coding in a variable-length coding part 13. The resultant signal in the form of a bitstream is then transmitted to an MUX or receiver.

The variable-length coding part 13 receives, as an input thereof, the DCT coefficients outputted from the scanning part 12

10 and carries out a variable-length coding for the transform coefficients arranged in a one-dimensional array in a sequential manner.

Now, the variable-length coding for transform coefficients will be described in conjunction with H. 263 which is a

15 representative of conventional variable-length coding schemes. In accordance with this scheme, EVENTs of transform coefficients with values not being "zero" are first derived. For the derive EVENTs, corresponding bitstreams are then sought from a given variable-length coding (VLC) table. Thereafter, the sought

20 codes are sequentially outputted. Each EVENT consists of a combination of three kinds of information, namely, a LAST indicative of whether or not the transform coefficient being

-12-

13

currently encoded is the last non-zero transform coefficient, a

RUN indicative of the number of successive zero transform

coefficients preceding the current non-zero coefficient and a

LEVEL indicative of the magnitude of the current transform

5   coefficient.

Such EVENTs, which are combined and defined as mentioned

above, can be entropy-coded through a variable-length coding

such as Huffman coding or arithmetic coding. This is, a smaller

amount of bits are allocated for EVENTs exhibiting a higher

10   occurrence probability. On the other hand, a larger amount of

bits are allocated for EVENTs exhibiting a lower occurrence

probability. Accordingly, it is possible to achieve coding of

EVENTs using a considerably reduced number of bits, as compared

to a fixed-length coding (FLC).

15   A part of a VLC table that used for H.263. is illustrated in

Table 1.

INDEX	LAST	RUN	LEVEL	BIT	VLC CODE
0	0	0	1	3	10s
1	0	0	2	5	1111s
2	0	0	3	7	0101 01s
3	0	0	4	8	0010 111s
4	0	0	5	9	0001 1111s
5	0	0	6	10	0001 00101s
6	0	0	7	10	0001 0010 0s
7	0	0	8	11	0000 1000 01s
8	0	0	9	11	0000 1000 00s
9	0	0	10	12	0000 0000 111s
10	0	0	11	12	0000 0000 110s
11	0	0	12	12	0000 0100 000s
12	0	1	1	4	110s
13	0	1	2	7	0101 00s
14	0	1	3	9	0001 1110s
15	0	1	4	11	0000 0011 11s
16	0	1	5	12	0000 0100 001s
17	0	1	6	13	0000 0101 0000s
18	0	2	1	5	1110s
19	0	2	2	9	0001 1101s
20	0	2	3	11	0000 0011 10s
21	0	2	4	13	0000 0101 0001s
22	0	3	1	6	0110 1s
23	0	3	2	10	0001 0001 1s

-14-

15

24   0   3   3   11   0000 0011 01s

ппппшппппппппшпппппппшппппппппппппппппппшппппппшшппппппппшшшп

In the Table 1, the first column represents indexes for

5   distinguishing EVENTs from one another. The second column

represents LASTs. LAST=0 denotes that coefficient to be coded

is not the last non-zero transform coefficient whereas LAST=1

denotes that the coefficient is the last one. The third column

represents RUNs. The fourth column represents LEVELs indicative

10   of values of transform coefficients. The fifth column

represents the number of bits generated for each EVENT. The last

column represents a bitstream generated for each EVENT. In the

last column, "s" is indicative of the sign of each LEVEL. A s

of "0" (s = 0) is indicative of the fact that the associated LEVEL

15   is a positive number whereas a s of "1" (s = 1) is indicative of

the fact that the associated LEVEL is a negative number.

With regard to the occurrence probability of EVENTs, it

should be noted that EVENTs exhibit a lower occurrence

probability at greater RUN values and a higher occurrence

20   probability at smaller RUN values. Where the variable-length

coding is conducted, taking RUNs into consideration, accordingly,

a larger amount of bits are allocated for an EVENT with a greater

-15-

16

RUN value whereas a smaller amount of bits are allocated for an EVENT with a smaller RUN value. Referring to the VLC table of H.263 as shown in Table 1, such a feature can be clearly understood. This will be exemplarily described in conjunction with EVENTs

5   (INDEX = 1, 13, 19) respectively having RUNs of 0, 1, 2, along with LAST = 0 and LEVEL = 2.   For the EVENT bearing INDEX = 19 (LAST = 0, RUN = 2, and LEVEL = 2),   nine bits are allocated.   Seven bits are allocated for the EVENT bearing INDEX = 13 (LAST = 0, RUN = 1, and LEVEL = 2).   On the other hand, five bits are allocated for

10 the EVENT bearing INDEX = 1 (LAST = 0, RUN = 0, and LEVEL = 2). Thus, a larger amount of bits are allocated at a greater RUN value under the condition in which the LAST and LEVEL values are fixed.

Known shape-adaptive DCT coding schemes may use the above mentioned transform coefficient VLC method or VLC table. This

15 will be exemplarily described in conjunction with Figs. 8A to 8E. Fig. 8A shows the result obtained after carrying out a shape-adaptive DCT and quantization for an image signal in the form of an 8x8 block. In Fig. 8A, the dark segments correspond to object pixels of the block, respectively. Accordingly, the dark

20 segments   correspond   to   segments   containing   transform coefficients generated due to the object pixels. The remaining

-16-

17

bright segments are indicative of segments containing no transform coefficient, thereby being set with a transform coefficient value of "0". In each dark segment, "Xij" represents a transform coefficient positioned at an i-th position in a

5   horizontal direction and a j-th position in a vertical direction in 8x8 block. When all transform coefficients of the block are scanned in a zig-zag scanning order, they are arranged in the order of X11, X12, X21, X31, X22, X13, X14, 0, X32, X41, X51, X42, 0, 0, X15, X16, 0, 0, 0, X52, X61, X71, 0, 0, ..., and 0. If the

10   transform coefficient X71 is not zero, then the variable-length coding can be carried out only for segments positioned within the region defined by the thick solid line of Fig. 8B. Fig. 8C illustrates the case in which two transform coefficients X32 and X42 are zero whereas the remaining transform coefficients having

15   non-zero values, respectively. When the transform coefficient X41 is encoded in this case, its LAST value is zero because it is not the last one of non-zero transform coefficients in the block. In this case, LEVEL and RUN values are X41 and 2, respectively. With regard to the transform coefficient X41, such an increase

20   in RUN value caused by the transform coefficient X32 having a value of zero is reasonable because the zero value of the transform coefficient X32 is generated in accordance with a

-17-

18

signal information of associated object.   However, the transform
coefficient value of zero existing between the transform
coefficients X14 and X32 is a value not generated in accordance
with the object information transform, but given for a segment
5   containing   no   transform   coefficient.   Accordingly,
transmission of such information is unnecessary and rather
results in an increase in RUN value. As a result, there is a
disadvantage in that an increased number of bits is generated.
This causes a reduction of the coding efficiency of the
10   shape-adaptive DCT coding.

Although problems involved in the conventional shape-
adaptive DCT coding, which is a representative shape-adaptive
transform coding scheme, have been described, other shape-
adaptive transform coding schemes also have the same problems.
15   That is, the conventional shape-adaptive transform coding
schemes have a problem in that an addition of unnecessary values
of zero is involved in the scanning procedure.

Meanwhile, a variety of VLC coding schemes for carrying out
a VLC for transform coefficients have been used. Although the
20   VLC table of H.263 has been exemplified in the above description,
a VLC table consisting of a combination of only RUN and LEVEL is
used in the cases of JPEG, MPEG-1, and MPEG-2.   In this case,

-18-

19

however, the above mentioned problem namely, reduction of coding

efficiency, also occurs because an increase in RUN value results

in an increase in the number of coding bits occurs.

5 *CL*   SUMMARY OF THE INVENTION

P   Therefore, an object of the invention is to overcome the

above mentioned problems and to provide an object-based coding

apparatus and method for image signals, wherein upon scanning

10 shape-adaptive transform coefficients of an input image signal

transformed in accordance with a shape-adaptive transform for an

object-based coding thereof, only segments containing such

shape-adaptive transform coefficients are scanned, thereby

reducing the quantity of data being encoded.

15 Another object of the invention is to provide an object-

based decoding apparatus and method for image signals capable of

effectively decoding image data transmitted after being encoded

in accordance with a coding method of the present invention.

20 *CL*   BRIEF DESCRIPTION OF THE DRAWINGS

DR + CL

P   Other objects and aspects of the invention will become

-19-

20

apparent from the following description of embodiments with reference to the accompanying drawings in which:

P Fig. 1 is a view illustrating a test image for explanation of an object-based coding scheme;

5   *P* Fig. 2 is a view illustrating the shape information of the test image shown in Fig. 1;

P Fig. 3 is a schematic view illustrating object blocks for a shape-adaptive transform coding;

P Fig. 4 is a schematic view for explanation of the shape-adaptive transform coding for each block of Fig. 3;

10 Figs. 5A to 5F are schematic views respectively illustrating successive steps involved in a general shape-adaptive DCT procedure;

Fig. 6 is a block diagram illustrating a conventional shape-adaptive image signal coding apparatus;

15 Figs. 7A to 7C are schematic views for explanation of scanning methods to which the present invention is applicable, respectively;

Figs. 8A to 8E are schematic views for explanation of a VLC method for quantized transform coefficients, respectively;

20 Fig. 9 is a block diagram illustrating an object-based image signal encoder according to the present invention;

-20-

Fig. 10 is a block diagram illustrating an object coding unit according to the present invention;

Fig. 11 is a block diagram illustrating an object-based coding of image signals in accordance with the present invention;

5   Figs. 12A and 12B are block diagrams respectively illustrating different embodiments of a shape-adaptive scanning part according to the present invention;

Fig. 13 is a block diagram illustrating an object-based image signal decoder according to the present invention;

10   Fig. 14 is a block diagram illustrating an object decoding part according to the present invention;

Fig. 15 is a block diagram illustrating an apparatus for object-based decoding of image signals in accordance with the present invention; and

15   Figs. 16A and 16B are block diagrams respectively illustrating different embodiments of a shape-adaptive inverse scanning part according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

20

Figs. 9 to 11 illustrate respective object-based image signal coding systems to which the present invention is

-21-

applicable. Fig. 9 is a block diagram illustrating a general object-based image signal coding system. This system is adapted to divide an input image signal into object each having arbitrary shape information and to carry out a coding operation for each of

5 the object. An input image signal is first applied to an object formation part 1 included in the objected-based image signal encoder. In the object formation part 1, the input image signal is divided into each object. The object formation part 1, then derives shape information and texture information for each

10 object. The resultant signals for each object are applied to an object coding part 2 which, in turn, conducts a coding operation for those signals. This coding operation of the object coding part 2 is sequentially carried out for all objects (2-1, 2-2, ..., and 2-n). Outputs resulting from the object coding for all

15 objects, namely, bitstreams are then multiplexed in a multiplexer (MUX) which, in turn, sends the resultant signal to a receiver or storage media.

Fig. 10 illustrates the configuration of an object coding unit included in the object coding part 2 of Fig. 9. Although the

20 object coding part 2 is shown in Fig. 9 as consisting of a plurality of object coding units, it practically includes a single object coding unit which repeatedly performs a coding

-22-

23

operation by n times (2-1, 2-2, ..., and 2-n) for n objects.

Signal information of each object, which is inputted at the object coding unit, are divided into shape information and texture information. These shape information and texture

5 information are first inputted in a shape information coding part 20 and a motion estimation part 21, respectively.

The shape information coding part 20 serves to encode the shape information of the associated object. The resultant reconstructed shape information is then applied to a motion

10 estimation part 21, motion compensation part 22 and a texture information coding part 24. Thus, the operation of each part is carried out on an object basis. Meanwhile, a shape information bitstream, which is another output from the shape information coding part 20, is inputted to a multiplexer 25.

15 The reconstructed shape information controls motion estimation, motion compensation, texture information coding. In order to control a decoding apparatus in the same way as above, the reconstructed shape information of an encoder should be coincide with a reconstructed shape information in the form of

20 shape information bitstreams received by the decoding apparatus. On the other hand, in case that lossless coding is carried out in the shape information coding part, the reconstructed shape

-23-

information is identical with the input shape information. In case of lossy coding, the reconstructed shape information is different from the input shape information. Therefore, controlling process for object-based coding of image signal is

5   performed by using not the input shape information but the reconstructed shape information. The shape information disclosed hereinafter is reconstructed shape information unless otherwise noted.

The motion estimation part 21 serves to estimate motion

10 information of the texture information of the current object using the texture information of the current object and the texture information of the previous object stored in a previous reconstructed object information memory 27.   The motion information is input to the motion compensation part 22 for a

15 motion compensated prediction.   The estimated motion information is efficiently encoded and then the resultant motion information bitstream is input to the multiplexer 25.   The motion compensation part 22 carries out a motion compensated prediction using the motion information derived by the motion estimation

20 part 21 and the previous reconstructed object texture information stored in the previous reconstructed object information memory 27.

-24-

A subtractor 23 calculates a prediction error, namely, a difference between the input texture information and the motion compensated prediction texture information derived by the motion compensation part 22. The resultant signal from the subtractor

5   23 is encoded in the texture information coding part 24. The resultant texture information bitstream from the texture information coding part 24 is applied to the multiplexer 25 and the reconstructed prediction error signal is applied to an adder 26. This adder 26 adds the reconstructed error signal to the

10 motion compensated prediction signal, thereby generating a reconstructed texture information signal of an associated object. This reconstructed texture information signal is stored in the previous reconstructed object information memory 27 so that it is used for coding of an object to be subsequently inputted.

15   Using the reconstructed shape information received from the shape information coding part 20, the texture information coding part 24 encodes the texture information of an associated object. In the texture information coding part 24, the coding operation is not carried out for entire object, but carried out on a block

20 basis which is pixel set having a certain size, for example, a MxN size.

Meanwhile, although the texture information coding part of

-25-

Fig. 10 is illustrated as being adapted to encode prediction error

signals, it may be possible to encode input texture information

in place of such prediction error signals. In this regard, it is

possible to achieve an improvement in coding efficiency by

5   adaptively encoding a selected signal enabling more efficient

coding thereof out of the prediction error signal and texture

information signal. For example, where motion information

estimation is inaccurately carried out, the resultant prediction

error signal has an increased value. In this case, accordingly,

10   it is preferred that the input texture information be encoded,

because a smaller number of bits are generated. Where coding of

input texture information is carried out, it is unnecessary to use

an adder operation for adding the reconstructed texture

information to the prediction signal. Therefore, the coding

15   part generally includes a control unit for determining a suitable

mode and carrying out a control based on the determined mode, even

though not shown in Fig. 10.

Fig. 11 illustrates an apparatus for object-based coding of

image signals in accordance with the present invention. This

20   apparatus corresponds to the texture information coding part(24)

of Fig. 10. As shown in Fig. 11, the object-based coding

apparatus for image signals according to the invention

-26-

comprises:

𝑃 1   a shape information coding part for encoding shape
information of an input image signal;

𝑃 1   a shape-adaptive transform part for carrying out a shape-

5   adaptive transform for texture information of said input image
signal, based on said shape information outputted from said shape
information coding part;

𝑃 1   a shape-adaptive scan control part for forming a binary
coefficient mask having the same transform coefficient

10   distribution as that of an output signal from said shape-adaptive
transform part, and generating a scan control signal in
accordance with existence or nonexistence of a transform
coefficient based on said binary coefficient mask; and

𝑃 1   a shape-adaptive scanning part for carrying out a scanning

15   operation for an output from said shape-adaptive transform part,
based on the associated control signal from said shape-adaptive
scan control part.

𝑃   The shape-adaptive scan control part 240 of the object-
based coding apparatus comprises:

20   𝑃 1   a coefficient forming unit 241 adapted to form a binary
coefficient mask for sorting segments containing transform
coefficients from segments containing no transform coefficient

-27-

28

which has the same transform coefficient distribution as that of

an output signal from said shape-adaptive transform part; and

𝑃𝐼   a control signal generation unit 242 adapted to generate a

skip signal for skipping segments containing no transform

5   coefficient from the scanning operation of said shape-adaptive

scanning part.

𝑃   The shape-adaptive scan control part 240 receives

reconstructed shape information from the shape information

coding part 20 of Fig. 10, thereby generating a control signal for

10   sorting segments containing transform coefficients from

segments containing no transform coefficient so as to control a

scanning operation in such a manner that the segments containing

transform coefficients are scanned in a scan order while the

segments containing no transform coefficient are excluded from

15   the scan order.

𝑃   The coefficient forming unit 241 is adapted to transform the

input reconstructed shape information in the same manner as in a

shape-adaptive transform coding, thereby forming a coefficient

mask which denotes a region of segments having a transform

20   coefficient (transform coefficient region) so as to sort segments

containing transform coefficients from segments containing no

transform coefficient. The scan control signal generation unit

-28-

242 serves to scan the coefficient mask in the same manner as in the scanning of transform coefficients and to generate a signal indicative of whether or not the currently scanned mask corresponds to the transform coefficient region.

5   ρ The apparatus further includes a shape-adaptive scanning part 245 which scans quantized coefficients contained in the segments containing transform coefficients while excluding the segments containing no transform coefficient, thereby skipping them, in response to the control signal generated from the

10   shape-adaptive scan control part 240.

The shape-adaptive scanning part(245) according to the present invention also receives transform coefficients outputted from a shape-adaptive transform unit(243) and conducts a scanning operation for arranging those transform

15   coefficients in a one-dimensional array. During the scanning operation, the shape-adaptive scanning part receives a control signal - a signal indicative of whether or not the currently scanned segment contains an associated transform coefficient - from the shape-adaptive scan control unit, in order to exclude

20   segments containing no transform coefficient from the scan order, namely, to prevent zero coefficients of those segments from being included in the one-dimensional array.

-29-

30

P   In other embodiment of the present invention, the shape-adaptive scanning part 245 comprises:

P   a scanning unit 245-1 adapted to scan the entire segment including segments containing shape-adaptive transform

5   coefficients and segments containing no transform coefficient, but respectively filled with coefficients of a predetermined value; and

P   a switching unit 245-2 adapted to receive an output signal from said scanning unit and to switch off said output signal from

10   said scanning unit, based on said skip signal from said control signal generation unit, when said output signal is associated with a segment containing no transform coefficient.

P   In accordance with the present invention, therefore, it is possible to reduce the number of zero coefficients unnecessarily

15   inserted irrespective of non-existence of transform coefficients in the case of the conventional scanning methods. This results in an advantage of an improvement in coding efficiency.

P   Now, the operation of the object-based image signal coding

20   apparatus of Fig. 11 according to the present invention, which corresponds to the texture information coding part 24 of Fig. 10, will be described in detail. When a boundary block as shown in

-30-

31

Fig. 4 is inputted at the input stage of a shape-adaptive

transform unit 243, it is processed by the well-known shape-

adaptive transform, so that the shape-adaptive transform unit

243 outputs shape-adaptive transform coefficients.   In this case,

5   the texture information signal inputted at the shape-adaptive

transform unit 243 may be a prediction error signal as used in the

case of Fig. 10.   Alternatively, an input texture information

signal may be inputted where the prediction error signal has a

large value.   Such an input mode selection has no direct relation

10   with the present invention.   The shape-adaptive transform unit

243 also receives reconstructed shape information outputted from

the shape information coding part 20 of Fig. 10 in order to

determine which pixels correspond to object pixels.   The number

of transform coefficients outputted from the shape-adaptive

15   transform unit 243 is equal to the number of object pixels.

Where the transform coding used is the shape-adaptive DCT, the

transform coefficients are arranged in a manner as described in

conjunction with Fig. 5.   Referring to this example, it can be

found that the transform coefficients outputted from the

20   shape-adaptive transform unit 243 have a different arrangement

from the shape information inputted at the same unit 243.

Accordingly, it is necessary to change the arrangement of the

-31-

32

input shape information so that it is identical to that of the

transform coefficients. This arrangement change is carried out

in the coefficient mask forming unit 241. This will be described

in more detail. The input of the coefficient mask forming unit

5   241 is the input shape information whereas the output of the same

unit 241 is shape information having an arrangement identical to

the arrangement of the transform coefficients outputted from the

shape-adaptive transform unit 243. That is, the coefficient

mask forming unit 241 forms a coefficient mask for determining

10 whether or not the currently scanned segment contains an

associated transform coefficient. The coefficient mask output

from the coefficient mask forming unit 241 is applied to the scan

control signal generation unit 242 via an output stage thereof.

Based on such shape information, the scan control signal

15 generation unit 242 controls the shape-adaptive scanning part

245.

The transform coefficients from the shape-adaptive

transform unit 243 are applied to a quantization part 244 which,

in turn, carries out a quantization for the received transform

20 coefficients. The quantized transform coefficients are

transmitted to the shape-adaptive scanning part 245 which, in

turn, arranges the received transform coefficients in a one-

-32-

dimensional array. The transform coefficients arranged in a
one-dimensional array are applied to a variable-length coding
part (VLC) 246 which, in turn, conducts a coding operation for the
received   transform   coefficients,   thereby   outputting   an
5   associated bit stream. In the case of the well-known scanning
methods, a transform coefficient scanning operation is performed
for the entire segment of a block, as shown in Figs. 7A to 7C. In
the shape-adaptive transform, however, only the transform
coefficients respectively associated with pixels included in the
10   object region are transmitted. In this case, the arrangement of
the transform coefficients outputted from the shape-adaptive
transform unit 243 or quantization part 244 is changed depending
on the shape information. Accordingly, the control signal
generation unit 242 generates a signal indicative of whether or
15   not the currently scanned mask region corresponds to the
transform coefficient region, based on the shape information
outputted from the coefficient mask forming unit 241, while
conducting its scanning operation in the same manner as in the
shape-adaptive scanning part 245, based on the shape information
20   outputted from the coefficient mask forming unit 241.   As
mentioned hereinbefore, the shape information outputted from the
coefficient mask forming unit 241 has the same arrangement as that

-33-

34

of the transform coefficients outputted from the shape-adaptive

transform unit 243. Therefore, the scan control, which is

carried out based on such shape information, makes it possible to

effectively eliminate unnecessary information possibly

5   generated in the shape-adaptive transform coding. Thus, there

is an advantage of an improvement in coding efficiency.

Figs. 12A and 12B illustrate embodiments of the shape-

adaptive scanning part 245 according to the present invention,

respectively. In the case of Fig. 12A, the shape-adaptive

10 scanning part 245 includes a scanning unit 245-1 and a

switching unit 245-2. The shape-adaptive scanning unit 245-1

is configured to operate in the same scanning manner as in the

conventional scanning method of Figs. 7A to 7C. The switching

unit 245-2 serves to carry out its switching operation in

15 accordance with a control signal received from the shape-

adaptive scan control unit 245-1. Where the control signal

applied to the switching unit 245-2 is indicative of a segment

containing no transform coefficient, the switching unit 245-2 is

switched off. The switching unit 245-2 is also switched on when

20 the control signal applied thereto is indicative of a segment

containing a transform coefficient. In accordance with such an

operation of the switch controlled in response to the control

-34-

35

signal, the shape-adaptive scanning part generates its output

only for segments containing transform coefficients. This will

be described in more detail in conjunction with Fig. 8C.

Assuming that the scanning method used is a zig-zag scanning

5   method, the shape-adaptive scanning part outputs X11, X12, X21,

X31, X22, X13, X14, 0, 0, X41, X51, 0, 0, 0, X15, X16, 0, 0, 0,

X52, and X71.   The control signal generation unit of the

shape-adaptive scan control part, which receives the transform

coefficient position information as shown in Fig. 8C, scans all

10 segments in the same order as in the zig-zag scanning carried out

in the shape-adaptive scanning.   When the control signal

generation unit scans a segment containing a transform

coefficient, it generates a control signal for switching on the

switch.

15   P   The control signal generation unit 242 also outputs a

control signal for switching off the switching unit 245-2 when

it scans a segment containing no transform coefficient. Thus,

the switching unit 245-2 outputs X11, X12, X21, X31, X22, X13,

X14, 0, X41, X51, 0, X15, X16, X52, and X71 while receiving inputs

20 of X11, X12, X21, X31, X22, X13, X14, 0, 0, X41, X51, 0, 0, 0, X15,

X16, 0, 0, 0, X52, and X71.

P   On the other hand, the object-based image signal coding

-35-

36

apparatus shown in Fig. 12B includes a shape-adaptive scanning

part 245 configured to control its scanning operation by a control

signal, as compared to the case of Fig. 12A in which the

object-based image signal coding apparatus includes a scanning

5   unit 245-1 configured to operate in the same scanning manner as

in the conventional scanning method, and a switch controlled by

a control signal. In the case of Fig. 12B, a new scanning scheme

is defined and used. That is, the shape-adaptive scanning part

of Fig. 12B itself operates to skip segments containing no

10   transform coefficient while basically operating in the same

manner as in the conventional scanning method. Assuming that

this shape-adaptive scanning part 245 basically operates in a

zig-zag scanning fashion and receives the transform coefficient

position information as shown in Fig. 8C, it carries out a

15   scanning operation in accordance with a new scanning scheme shown

in Fig. 8D, in response to a control signal applied thereto. The

shape-adaptive scanning part245 of Fig. 12B may also basically

use the scanning scheme as shown in Fig. 7B or 7C. Thus, the

scanning scheme intended in this embodiment may be determined in

20   accordance with the input shape information and the basic

scanning scheme used. Of course, both the embodiments of Figs.

12A and 12B provide the same result where the same input shape

-36-

information and the same basic scanning scheme are used.

Although not shown in Fig. 11 and Fig. 12, the texture information coding part should include a unit adapted to reconstruct an encoded texture information signal. Generally,

5   this unit carries out an inverse quantization procedure and an inverse transform procedure. The resultant reconstructed texture information signal is applied to the adder of Fig. 10.

Figs. 13 and 14 illustrate an object-based image decoding system in accordance with the present invention. Fig. 13

10   illustrates a block diagram schematically illustrating an object-based image decoding system according to the present invention. A bitstream, which is received in the object-based image decoding system, is divided into bitstreams respectively associated with objects. The resultant object bitstreams are

15   decoded in an object decoding part 32 in association with objects, respectively. The resultant reconstructed object signals from the object decoder 32 are composed by a composition part 33, thereby generating and displaying a single image signal.

Fig. 14 is a block diagram illustrating a detailed

20   configuration of the object decoding part 32 according to the present invention. Although the object decoding part 32 is shown in Fig. 13 as consisting of a plurality of object decoding units,

-37-

38

it practically includes a single object decoding unit which repeatedly performs a decoding operation by n times (32-1, 32-2, ..., and 32-n) for n objects. The illustration of Fig. 13 is only to emphasize individual decoding operations of the object

5   decoding part 32 for objects. A bitstream, which is received in the object decoding part 32, is demultiplexed into a motion information bitstream, a shape information bitstream, and a texture information bitstream via a demultiplexer (DEMUX) 41. The separated bitstreams are then applied to decoding parts 42

10   to 44, respectively. The shape information decoding part 43, which receives the shape information bitstream, generates reconstructed shape information. This reconstructed shape information is applied the texture information decoding part 44. The reconstructed shape information is also applied to a motion

15   compensation part 45. Thus, decoding is carried out for each object. That is, reconstruction of pixels only included in the object region is possible. The texture information decoding part 44 receives the texture information bitstream, thereby conducting a texture information decoding operation. In order

20   to decode only the texture information associated with the object region, the texture information decoding part 44 also receives the reconstructed shape information and uses it upon decoding the

-38-

39

texture information. The motion information decoding part 42

receives the motion information bitstream, thereby conducting a

motion information decoding operation. The motion compensation

part 45 carries out a motion compensated prediction, based on the

5   motion information outputted from the motion information

decoding part 42 and the previous texture information from a

previous reconstructed object memory part 46. Of course, the

operation of the motion compensation part 45 is carried out only

in association with the object region. To this end, the

10 reconstructed shape information outputted from the shape

information decoding part 43 is also applied to the motion

compensation part 45. This reconstructed shape information is

identical to the reconstructed shape information outputted from

the shape information coding part of Fig. 10. A motion

15 compensated prediction signal outputted from the motion

compensation part 45 is added to the reconstructed texture

information from the texture information decoding part 44 in an

adder 47, thereby recovering the associated object. The

recovered object is stored in the previous reconstructed object

20 memory 46 so that it is subsequently used upon decoding of the next

frame. The recovered object is also applied to a composition

part so that it is composed with other objects, thereby

-39-

reproducing an image signal.

Fig. 15 is a block diagram illustrating an apparatus for shape-adaptive decoding of image signals in accordance with the present invention. This apparatus corresponds to the texture

5   information decoding part 44 of Fig. 14. As shown in FIG. 15, the object-based decoding apparatus for image signals according to the invention comprises:

a shape information decoding part for decoding shape information associated with objects and contained in an object

10   bitstream transmitted from a coding apparatus;

a shape-adaptive inverse scan control part 440 for forming a binary coefficient mask, based on said shape information received from said shape information decoding part, and generating an inverse scan control signal in accordance with

15   existence or nonexistence of the coefficient mask;

a shape-adaptive inverse scanning part 444 for performing an inverse scanning operation to arrange transform coefficients of texture information contained in said object bitstream in the form of a two-dimensional signal, based on said inverse scan

20   control signal from said shape-adaptive inverse scan control part; and

a shape-adaptive inverse transform part 446 for performing

-40-

a   shape-adaptive   inverse   transform   for   the   transform

coefficients inversely scanned by said shape-adaptive inverse

scanning part, based on said decoded shape information outputted

from   said   shape   information   decoding   part,   thereby

5   reconstructing texture information of an original image.

P   The   apparatus   includes   a   shape-adaptive   inverse   scan

control part 440 for receiving reconstructed shape information

outputted from a shape information decoding part 43, thereby

generating   a   control   signal   for   sorting   segments   containing

10   transform coefficients from segments containing no transform

coefficient so as to control an inverse scanning operation in such

a manner that the segments containing transform coefficients are

scanned   in   the   well-known   scan   order   while   the   segments

containing no transform coefficient are excluded from the scan

15   order.

P   The   shape-adaptive   inverse   scanning   part   444   of   the

apparatus which inversely the segments containing transform

coefficients   while   excluding   the   segments   containing   no

transform   coefficient,   in   response   to   the   control   signal

20   generated from the shape-adaptive inverse scan control part 440.

P   The   shape-adaptive   inverse   scan   control   part   440   operates

in the same manner as the shape-adaptive scan control part 240 of

-41-

42

Fig. 11. That is, the shape-adaptive inverse scan control part
440 includes a coefficient mask forming unit 441 adapted to
transform the input reconstructed shape information in the same
manner as in the shape-adaptive transform coding, thereby

5 forming a coefficient mask which denotes a region of segments
having a transform coefficient (transform coefficient region) so
as to sort segments containing transform coefficients from
segments containing no transform coefficient, and a control
signal generation unit 442 adapted to scan the coefficient mask

10 in the same manner as in the scanning of transform coefficients
and to generate a signal indicative of whether or not the
currently scanned mask segment corresponds to the transform
coefficient region.

P The shape-adaptive inverse scanning part 444 according to
15 the present invention also receives transform coefficients
outputted from a variable-length decoding unit 443 and conducts
a inverse scanning operation for arranging those transform
coefficients in the form of a two-dimensional signal. During the
inverse scanning operation, the shape-adaptive inverse scanning

20 part 444 receives a control signal - a signal indicative of
whether or not the currently scanned segment contains an
associated transform coefficient - from the shape-adaptive

-42-

43

inverse scan control unit 440, in order to skip segments

containing no transform coefficient from the scan order. In

accordance with the present invention, therefore, it is possible

to decode the bitstreams generated by way of reducing the number

5   of zero coefficients unnecessarily inserted irrespective of

non-existence of transform coefficients in the case of the

conventional scanning methods.

In accordance with an embodiment of the present invention

shown in Fig. 16A, the shape-adaptive inverse scanning part 444

10   is configured so that during its scanning of segments processed

by the variable-length decoding, it switches off outputting of

scanned transform coefficient values associated with segments

containing no transform coefficient, based on a skip signal from

the control signal generation unit 442. In accordance with

15   another embodiment of the present invention shown in Fig. 16B, the

shape-adaptive inverse scanning part 444 is configured so that

during its scanning of segments, it excludes segments containing

no transform coefficient from the scan order, thereby skipping

them, based on a skip signal from the control signal generation

20   unit 442.

In operation of the apparatus, a variable-length decoding

part 443 receives a bitstream of texture information, thereby

-43-

outputting transform coefficients arranged in a one-dimensional

array. The shape-adaptive inverse scan control part 440 has the

same configuration as the shape-adaptive scan control part of Fig.

11. The coefficient mask forming unit 441 outputs a coefficient

5   mask for determining whether or not the currently scanned segment

contains an associated transform coefficient. This information

is applied to the control signal generation unit 442 which, in

turn, outputs a control signal indicative of which segments have

no transform coefficient while inversely scanning the entire

10   segment in the same manner as in the shape-adaptive inverse

scanning part 444. The shape-adaptive inverse scanning part 444

conducts a procedure for re-arranging transform coefficients

outputted from the variable-length decoding part 443.

Thereafter, a dequantization for the transform coefficients is

15   carried out in a dequantization part 445. The resultant

transform coefficients are inversely transformed in a shape-

adaptive inverse transform unit 446, thereby reconstructing

texture information.

The shape-adaptive inverse scanning procedure according to

20   the present invention will be exemplarily described in

conjunction with Fig. 8C. The variable-length decoding part 443

outputs X11, X12, X21, X31, X22, X13, X14, 0, X41, X51, 0, X15,

-44-

45

X16, 0, X52, and X71 whereas the shape-adaptive inverse scanning

part 444 generates outputs as shown in Fig. 8E. In Fig. 8E, the

bright portions correspond to segments containing no transform

coefficient. These segments are not subject to an object-based

5   decoding. Even when these segments are filled with arbitrary

values, the decoding part is not influenced by them. The inverse

scanning unit 444-1 of Fig. 16A is configured to operate in the

same scanning manner as in the conventional scanning method while

using a switching unit 444-2 controlled by a control signal.

10   On the other hand, the shape-adaptive inverse scanning part of

Fig. 16B uses a new inverse scanning scheme as shown in Fig. 8D.

The inverse scanning procedure according to the present

invention may be carried out using a zig-zag scanning scheme or

other scanning schemes.

15   As apparent from the above description, the present

invention provides object-based coding and decoding apparatuses

and methods for image signals, wherein upon scanning shape-

adaptive transform coefficients of blocks transformed in

accordance with a shape-adaptive transform, only segments

20   containing such shape-adaptive transform coefficients are

scanned. In the scanning operation, segments containing no

transform coefficient are skipped. As a result, it is possible

-45-

46

to suppress transmission of unnecessary bits. Accordingly, there are redundant bits which can be used for an improvement in picture quality. This results in an improvement in the quality of image services.

5 Although the preferred embodiments of the invention have been disclosed for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope and spirit of the invention as disclosed in the accompanying claims.

-46-

47